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his work). Their counting chamber was a Rutherford and Geiger's spherical chamber with gas at reduced pressure. They obtained 2.92×10^{10} γ-rays from radium B and C per second per gram of radium. The material of their counting chamber was copper. In view of my results with chambers of different materials I decided to continue my experiments on this point especially as my results indicated that Lawson and Hess's value is probably low. My results at present indicate a value of 7×10^{10} γ-rays from radium B and C per second per gram of radium.

[1] Geiger, H., *Verh. D. Phys. Ges.*, **15**, 1913 (534).

[2] Kovarik, A. F., and McKeehan, L. W., *Physik. Z.*, **15**, 1914 (434).

[3] Kovarik, A. F., and McKeehan, L. W., *Physic. Rev.*, N. S., **6**, 1915 (426).

[4] Kovarik, A. F., and McKeehan, L. W., *Ibid.*, **8**, 1916 (574).

[5] Kovarik, A. F., and McKeehan, L. W., *Ibid.*, **13**, 1919 (272).

[6] Hess, V. F., and Lawson, R. W., *Sitzb. Akad. Wien*, **125**, 1916 (585).

ON THE NATURE OF THE HEAT PRODUCTION IN A SYSTEM OF PLATINUM BLACK, ALCOHOL, AND AIR

BY L. B. LOEB

NATIONAL RESEARCH FELLOW, RYERSON PHYSICAL LABORATORY, UNIVERSITY OF CHICAGO

Communicated by R. A. Millikan, January 16, 1920

When a small quantity of platinum black is introduced into an atmosphere of air saturated with ethyl or methyl alcohol vapor a violent reaction takes place on the surface of the platinum causing it to become incandescent.

The nature of this reaction has been explained in two ways. It is held by some that owing to the vast surface and poor heat conductivity of platinum black the adsorption of the alcohol vapor liberates sufficient heat to raise the temperature of the platinum considerably. This rise in temperature is supposed to accelerate the rate of oxidation of the alcohol vapor in the neighborhood of the platinum thus further raising its temperature until the substance becomes incandescent.*

On the other hand it is held by others that the heat produced at the surface of the platinum black is due primarily to the oxidation of the alcohol at the surface of the platinum. The adsorption of the alcohol is in this case considered as contributing relatively little heat. The surface of the platinum is, however, supposed to exert a "catalytic" action on the alcohol vapor and oxygen increasing the speed of reaction to many times that in air at ordinary temperatures.

The writer's attention was called to the two explanations by Prof. Millikan and it occurred to the writer that a decision between the two explanations might easily be obtained experimentally. If a thermocouple

* This explanation is ascribed to Wilhelm Ostwald by Prof. P. Sabatier, in a course of lectures given students of the A. E. F., at Toulouse, France, in 1918.

be covered with platinum black it is an easy matter to determine the relative rise in temperature of the platinum black due to the adsorption of alcohol vapor in the presence and in the absence of air. Such experiments were performed by the writer. As the results were so decisive and as no reference to similar experiments could be found in the literature, a brief statement of the observations may be of interest.

About 0.41 gram of platinum black, prepared from $PtCl_4$ by precipitation with aluminium from an acid solution, was placed in a small beaker in a vacuum desiccator. The base of the desiccator contained a small quantity of H_2SO_4 which served to dry the platinum black. The beaker was surrounded as completely as possible with cotton wool to cut down convection currents. The junction of a "Chromel-Alumel" thermocouple of No. 18 wire welded by copper was buried in the heap of platinum black. The leads passed through a rubber stopper to the circuit of a galvanometer which was closed through a key.

The sensibility of the galvanometer used had several values lying between a deflection of 1 cm. scale reading for 4.9° C. change in temperature to 1 cm. scale reading for 0.36° C. change in temperature. Greater sensibility could not be used as the temperature changes due to compression and exhaustion of the air in the experiments were in the neighborhood of one degree. By means of a two-way stopcock the desiccator could alternately be exhausted by an air pump or filled with a mixture of CO_2 and CH_3OH, a mixture of air and CH_3OH, or by CO_2 alone. The gases were saturated with CH_3OH by bubbling through a small quantity of the liquid in the bottom of a bottle.

The following is the record of a typical experiment. After having been exposed to air and alcohol, the chamber was exhausted to about 2 cm. Hg pressure and washed out with CO_2 gas at least three times. The galvanometer deflection after each filling registered about 4 cm. corresponding to a rise of about 1.44° C. This was due to the heat of compression of the CO_2 on filling, as the pressure of the CO_2 in the generator was above that of the air. Exhaustion of the gas in the desiccator also caused a drop of temperature of about 0.4° C.

Alcohol vapor plus CO_2 was then admitted and the deflection amounted to 5.5 cm. or to about 1.98°. The rise due to adsorption of the alcohol, or due to *adsorption* and *oxidation* of adsorbed alcohol by the remnants of the adsorbed O_2 left on the platinum, therefore, amounted to about 0.54° C. The mean of a number of results gave the value of the rise produced due to adsorption as about 0.36° C.

If the gas admitted after exhaustion was a mixture of air and CH_3OH vapor, instead of CO_2 and CH_3OH, the resulting deflection was on the average 24 cm. at the end of about a minute. The sensibility of the galvanometer was less than before so that this corresponded to a rise of 34° C. Different sensibilities gave about the same value for the rise in temperature. In this case the deflection was not instantaneous but the temperature rose more gradually, reaching a maximum in about 45 seconds. After this it slowly fell as the alcohol and air were consumed in the immediate neighborhood of the platinum.

When air alone was admitted to the apparatus no appreciable rise in temperature was detected.

It is obvious that the heat liberated on the surface of platinum black due to adsorption alone either of air or of alcohol vapor is small compared to that liberated in the process of oxidation of the alcohol at the surface of the platinum. In fact, adsorption gives at most only 1% of the heat produced in these experiments.

It will be of interest to know whether this conclusion is also supported by other facts.

On the basis of a recent theory of Langmuir[1] that the layer of molecules of a gas *adsorbed* on a solid surface is never more than one molecule thick, it is possible with certain assumptions to calculate the rise in temperature of the platinum black. If one considers that the heat of adsorption is equal to the heat of condensation, if one neglects heat losses due to radiation, conduction, and convection, and if one assumes a definite radius for the particles of the platinum black the calculation is quite simple.

Let us assume that the platinum black is made up of aggregates of spheres of platinum whose diameter is 100 $\mu\ \mu$, or 1×10^{-4} cm. This is about the size of the colloidal gold particles of a gold suspension investigated by Zsigmondy.[2] Such an assumption is justifiable as the particles of platinum black used are certainly much larger than this.

Using 0.41 gram of platinum black we get

The number particles of diameter 1×10^{-4} cm. in 0.41 gram platinum black $= 3.75 \times 10^{10}$.

The total surface of all the particles $= 1.18 \times 10^{3}$ sq. cm.

On Langmuir's theory there should be $= 0.85 \times 10^{15}$ molecules of CH_3OH per square cm. surface in an adsorbed layer one molecule thick.

Total number of molecules of CH_3OH condensed on the surface of the platinum black $= 1 \times 10^{18}$ molecules.

Heat generated by these molecules on condensation equals heat of evaporation of the 10^{18} molecules $= 1.53 \times 10^{-2}$ calories.

The 0.41 gram of platinum will be raised 1.16° C. at 0° C. by this adsorption.

If the amount adsorbed were oxidized the temperature would be raised 19.8° C.

It is obvious that the relative values calculated on these assumptions are in approximate agreement with the values experimentally obtained. The surface of the platinum black is in reality much smaller than was assumed here. Furthermore the heat liberated by oxidation is continuously liberated as long as alcohol and oxygen are present, while in the case of adsorption the heat is all liberated in the short span of time during which the adsorbed layer is forming. It is therefore obvious that in spite of the fact that the heat of adsorption may be greater than that of condensation the rise in temperature observed would be mainly due to the oxidation of the alcohol as was found by experiment to be the case.

In view of what has preceded it is to be concluded that the rise in temperature of the platinum black due to adsorption of the alcohol vapor is not the initiator of the reactions which heat the platinum to incandescence. For the heat generated by adsorption is negligible compared to that produced by oxidation and would not be capable of increasing the speed of reaction appreciably.

It is then on the basis of an increased rate of oxidation of the alcoho at the surface of the platinum ("catalytic" action) coupled with the physical properties of the platinum black that one must explain the rise in temperature. In this, one is justified to some extent, for it has long been known that surfaces of platinum accelerate certain chemical reactions, both in gases and in solution. Recently, Langmuir[1] has shown that at ordinary temperatures and at reduced pressures platinum foil when "activated" will cause oxygen and carbon monoxide to unite. In this case there seems to be some close relation between this action of platinum and adsorption, but it is not due to any heating effect.

[1] Langmuir, I., *J. Amer. Chem. Soc., Easton, Pa.*, **40,** 1918 (1361).

[2] Zsigmondy, R., *Zur Erkenntnis der Kolloide,* Jena, 1905 (104).

LEPTOSPIRA ICTEROIDES AND YELLOW FEVER

By Hideyo Noguchi

Rockefeller Institute for Medical Research, New York

Communicated by S. Flexner. Read before the Academy, November 10, 1919

Although yellow fever is being rapidly controlled by measures directed against the intermediate host (the Stegomyia mosquito), which acts as the vector, yet the nature of its inciting microbe has remained unknown. Hence yellow fever is a striking instance of the fact that given precise knowledge of the mode of infection of a microbic disease effective practical measures may be evolved for its control, even though the inciting microbe remain undiscovered.

Recently a fresh opportunity was afforded for the investigation of the etiology of yellow fever. The International Health Board of the Rockefeller Foundation sent a commission to Guayaquil, Ecuador, in June, 1918, to survey the field preparatory to the application of measures of control. Guayaquil has long been a recognized endemic focus of yellow fever, from which periodic extension has taken place to Central America.